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THE ORGANIZATION, DIRECTION AND SUPPORT OF RESEARCH IN THE PHYSICAL SCIENCES[1]

By Dr. HUGH S. TAYLOR

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THE ORGANIZATION OF RESEARCH

THE American nation is in process of assuming, through the power of her military, naval and air forces, and the technological organization requisite to that power, a position of major responsibility for peace and civilization in the post-war era. Adequately to meet the commitments which such a responsibility entails, the United States will, of necessity, be forced to enlarge both political and social horizons and at the same time to develop, to a degree hitherto unrealized, the scientific bases which that enhanced influence in the counsels of the world will, in large measure, require.

The progress of science and the technological changes that have resulted therefrom have proceeded with auto-accelerating pace over the last thirty years. Some concept of what the coming decades may hold can be learned from the history of this country during World War I and the interwar years with respect to scientific achievement, and the pattern there revealed will be a miniature of what must inevitably follow from the revolutionary changes in technology that the present war has produced. In 1914 American science looked to Europe for leadership. As Dr. C. M. Stine noted in an address to American chemists one year ago:

> It was a simple, almost a scientifically primitive economy in which we Americans then lived. On all the seven seas, America-bound ships heavy with goods and raw materials testified to our dependency on foreign lands. The homes in which we lived differed little from those of our great-grandfathers; the tailors of the Caesars knew the textiles of which we made our clothes; the finishes of our

[1] Read on November 19, 1943, in the Symposium on the Organization, Direction and Support of Research of the American Philosophical Society.

1914-model horseless carriages dated to ancient Egypt and the building of the Pyramids. All steel rusted. The best rubber tires were worn out after about 3,000 miles of highly uncertain road service.

One shudders at what might be our plight if those were the tires of to-day, or if by some colossal blunder we had failed to establish an organic chemical industry in the United States as a consequence of that other war's bitter lessons.

Thank God, we did establish a chemical industry!

We did more than that. We established a nation-wide common consciousness of the power of science in every branch of American industry. Steel, textiles, transportation, foods, oil, in fact every basic producer, came to the turn in the lane where all signposts of progress pointed in one direction—to the research laboratory. We did not get there all at once, but most of us got there long before German hob-nailed boots were pounding over the streets of Warsaw.

Expenditures for industrial research in the United States rose from an inconsequential sum yearly in the pre-World-War-I period, to an amount estimated at $300,000,000 yearly in the pre-World-War-II period. The number of research laboratories grew to more than 2,000. Huge sums were spent in expanding technical and scientific schools to meet the demands of our awakened youth. The number of doctorates granted in chemistry alone was multiplied by 20 or 30 times.

Similar if less immediate changes occurred in the science and technology of physics with advances in communications and transport, based upon electronics and aerodynamics, reaching a tremendous pace of growth only within the last few years. Mathematics, pure and applied, shared in the effort and took its part in the scientific and technical educational task that was required. Immediately after World War I, when the impact of war had revealed the necessity for expanded training in science, the Rockefeller Foundation initiated through the National Research Council in Washington a series of post-doctorate national research fellowships in astronomy, mathematics, physics and chemistry. These fellowships aimed initially at the building up of a scientific personnel from which the required enlarged body of college and university science professors could be drawn. The record shows abundantly how this was in large measure accomplished, and in our present stress we can see how far-sighted the policy was and how much to-day we lean for leaders upon the men so trained.

Industry also found that the available number of graduate students was inadequate to the demands of rapidly expanding programs of industrial research and itself took a hand in stimulating the supply. The E. I. du Pont de Nemours Company initiated such a venture early in 1922. To a selected group of universities with good reputations in chemistry, the company offered to the department of chemistry a fellowship at the graduate student level without any restrictions as to choice of fellow, nature of the research work pursued or ultimate ambition of the student selected. The aim was frankly to increase the number of students pursuing work for the doctorate in chemistry. The philosophy behind the fellowships was that, ultimately, an increase in the number and quality of graduate students in chemistry would mean an improved research personnel in their own laboratories. The example of the du Pont Company has been widely imitated by other chemical organizations. In physics, the policy has been notably less evident, but the current demand for research men in physics suggests that a similar intensive development of graduate students is due.

The universities themselves have contributed generously to the expansion of research personnel by the system of part-time assistantships. Here, also, owing to larger elections in the chemical field, the expansion has been greatest in the departments of chemistry, but the current demand for physicists and the probability that it will continue suggest that a similar measure of expansion is at hand in physics. It is via this path that many of the research personnel in industry and university have obtained their training for the doctorate in America, at least during one or two years of their training period. It is largely from the ranks of such assistants that the best are drawn to fill fellowship vacancies in the final years of study and research where freedom from other obligations constitutes a prime asset.

The growth of the educational supply to meet the research demand has led inevitably to steady improvement in the quality of educational and research activity in American colleges and universities in the inter-war years. American science and scientists have, in the main, been prepared for the tremendous calls that the present war has laid upon them. Leaders in the scientific effort have received a generous measure of support from educational foundations. There has grown up as a result, in and out of the universities, centers of research devoted to a group of connected problems. Dr. C. E. K. Mees, of the Eastman Kodak Research Laboratories, classifies such laboratories "as 'convergent' in distinction from the more usual 'divergent' laboratories, in which problems of many kinds are studied." Such a laboratory of the convergent type may well be described, Dr. Mees believes, as a "research institute," and it is this type of research institute that he expects to be the most important of the agencies for the production of fundamental science in the future. The research institute is a growth of the last half-century in the organization of research. It has grown out of the specialization of investigators, generally at universities, in some field of

work important enough to attract students to the field and resulting finally in the establishment of the laboratory in question as the center for research in the subject. Abroad and at home many examples may be cited. The Cavendish laboratory at Cambridge, under J. J. Thomson for the study of the electron and under Rutherford for radioactive and nuclear studies, the Leiden laboratories under Kammerlingh Onnes for low-temperature research, are examples from universities abroad. The Kaiser Wilhelm Institute for Physical Chemistry in Dahlem under Haber is an example of a research institute that grew out of foundation foresight and generosity. The Geophysical Laboratory at Washington and the Mount Wilson Observatory are research institutes in this country established by the Carnegie Institution. The grant by the International Education Board for the 200-inch telescope on Mount Palomar, California, and the appropriation by the Rockefeller Foundation to the University of California for the construction of the giant cyclotron designed by E. O. Lawrence directly tend to make of these centers research institutes of the type under consideration.

To a lesser degree, over the whole country, monetary grants in support of promising research work and research men are producing research institutes convergent rather than divergent in nature, within the framework of existing universities or as separate organizations with some degree of affiliation with college or university. We may cite in this connection the Institute of Paper Chemistry at Appleton, Wisconsin, and the Institute of Gas Technology, with headquarters in Chicago. The American Petroleum Institute has made Ohio State University the headquarters of research effort which also provides materials for research work in many institutions. The American Petroleum Institute for many years has sponsored a large program of research in the U. S. Bureau of Standards in Washington. This is true, also, of the Textile Foundation, and from this research effort may spring a central institute for fundamental research in textiles, affiliated with some educational foundation. Cellulose chemistry, the chemistry of starch and of sugar, are examples of other research efforts which may mature into research institutes of the type here under discussion. Some of the industrial research laboratories can indeed be described as research institutes. The research laboratories of the Eastman Kodak Company at Rochester can be cited as a Research Institute for Photography. The research laboratories of the General Electric Company at Schenectady, of the Bell Telephone Company at New York City and Summit, N. J., and that of the Westinghouse Company at Pittsburgh, Pa., rate high among the research institutes of the country. In this last case, the institute aspect of the enterprise has been emphasized by the short-term fellowship scheme for post-doctorate research men that the Westinghouse Company has sponsored. The regional laboratories of the U. S. Department of Agriculture, with laboratories devoted specifically to research in the principal agricultural products of the East, South, Central and Western areas of the country, are government-sponsored research efforts of the research institute type.

In England, there are parallel developments. Under the Department of Scientific and Industrial Research there are organizations such as the National Physical Laboratory and the Government Chemical Laboratory, and also a number of industrial research associations notably in cotton, wool and silk. The British Rubber Producers Research Association sponsors a broad program of fundamental research on rubber. The Fuel Research Board has conducted a comprehensive program on liquid fuels during the years between the two World Wars, and plans for fundamental research on coal have developed during the present war years. Naturally, under the stress of war requirements, the scientific establishments, in England as here, devoted to the special problems of war urgency have multiplied considerably.

It is a matter of universal experience that the conduct of warfare, on the scale and with the equipment that modern technology has made possible, requires a tremendous research potential behind the actual military forces. It is not surprising, therefore, in the light of the achievements of the Russian forces during the last two years, that, in Russia, can be found the most extensive planned development of the research institute. The organization of these institutes has been described by J. G. Crowther in his book, "Soviet Science." They stem from the Russian Academy of Sciences, and, under separate committees of academicians and associates, various groups of institutes are organized in each field of science. Among the more notable of these are the Academy of Agricultural Science, with N. I. Vavilov, the eminent geneticist, as one of its outstanding members, the Physico-Technical Institute directed by Joffe, the Institute for Chemical Physics, associated with N. Semenov, and the Optical Institute, the three last with headquarters in Leningrad, the Karpov Institute of Physical Chemistry at Moscow, and many others. The year 1942 gave Russian Soviet science a welcome opportunity to summarize the progress which had been achieved in 25 years from the Revolution of 1917. In this process of self-examination it was, in one place, concluded without hesitation

> that Soviet science does not lag behind scientific achievements in other countries and that Soviet scientists are leaders in many branches of science. . . . The orginal plan for expansion of the chemical industry during the third

five-year plan (1938–1942) which provided for a 237 per cent. expansion of chemical industry is being stressed. The war did not decrease the scope of this development. It only brought forward the practical requirements of the day.

In addition to steel, non-ferrous metals and the heavy chemical industry, petroleum, synthetic rubber, plastics and the synthetic fiber industry were all included in the scope of the plans. The research effort by 1941 had resulted in 40 special chemical research institutes, 70 chemical and chemical engineering schools or departments in technical colleges, with from 35,000 to 40,000 students and some 5,000 chemists and chemical engineers graduated each year. The losses sustained in the initial year of war were compensated "with a substantial margin" by evacuation and resumption of work in research institutes, colleges and industrial establishments in the eastern territories of the Soviet Union.

Institutes of the type here considered can be in no sense regarded as substitutes for the industrial research laboratory. These latter are essential if the new developments in fundamental science are to be translated into industrial processes and products. The research institute must be regarded, with the university research laboratory, as the principal source of that body of fundamental science which the industrial research laboratory will bring into practical application. The energetic demands for applied science now with us due to war have only served to show, in sharper focus, how the solutions of desired industrial problems are oftentimes delayed by gaps in our fundamental knowledge. In the solution of pressing war problems how often have we to lose time in learning the science underlying the desired application. The industrial laboratory must look in large measure to the university and research institute, even in normal times, for such basic data. The advantage which industry would reap therefrom would lie not so much in the immediate returns from the fundamental research but in the speed and economy of effort with which industry can utilize such effort in the solution of its own practical problems. The contrast between American technology in World War I and to-day, in the volume of technical effort that it can put forth and in the speed with which new problems can be solved, is undoubtedly due to the great growth of fundamental science in this country in the inter-war years.

There is another aspect of the problem of organization for scientific research in the post-war world that is so comprehensive as to be outside the scope of our present considerations but nevertheless of extreme importance for the successful solution of the problem and the correlation of that solution with other aspects of post-war life. It will be necessary to re-examine the general processes of education at the primary, high school and college levels if we are to provide an adequately trained and broadly educated personnel to enter the field of scientific research in the years ahead. The educational institutions of the country have been challenged by the events of recent years, and in the processes of self-examination the leaders of educational thought have discerned that all was not well with the educational activities of the inter-war era. It is recognized that in many respects education is at the cross-roads, and various challenging analyses of our earlier efforts have recently been issued. The new civilization that must emerge from the stress of these times will call for the education of man for freedom, for the formation of free men in free commonwealths. To secure this it will be necessary that the immense needs for technological and scientific training shall be balanced by competent education in the liberal arts and humane studies. A balance must, however, be maintained, so that science and research shall continue to attract a steady quota of the competent minds in each succeeding generation of students. Nor should their scientific orientation be unduly delayed by too great a monopoly of their earlier formative years in excessive devotion to non-scientific training. There is a general measure of agreement and a corresponding fund of good will to find a solution of this vital problem of early education in a blend of the essentials of a humanistic education with those elements of a liberal education that can best be aroused by the record of man's attainment, through the years, to his present status in science and the consequences of that achievement on the lives of us all.

The Direction of Research

The problem of direction of research is a personnel problem. It resolves itself when a competent director is found. If we think over the great centers of research in the physical sciences, whether in fundamental science or applied, do we not finally center our thoughts on the man who symbolized the laboratory? Berzelius, Arrhenius, Svedberg span a century in chemical science in Sweden; from Ostwald to Haber and Nernst runs the story of German research in physical chemistry. We think of the Cavendish laboratory in Cambridge in terms of Clerk Maxwell, Rayleigh, J. J. Thomson and Rutherford, of the Royal Institution in terms of Davy, Faraday, Dewar and Bragg. Michelson and Millikan, Richards, Compton, Lawrence, Whitney, Mees; is it not the directors who have made the research center by their own eminence in research or their own faculty of appraising the talents of others, organizing them and giving to them full scope? "I worked with X," is the formula that the young scientist will use to describe his training rather

than "I worked at Y," and in so doing he will reveal the qualities of inspiration and leadership that he had the good fortune to enjoy. He will have told of the "director" who did not direct, but drew forth from his associate the best that he could give.

There is no problem in discovering a research director when the institute grows from small beginnings around the pioneer in a new field. The speed with which the institute grows, the health of that growth, will largely lie in the capacities for direction which the pioneer himself possesses. There will be those who, in relative isolation, or at best with a few chosen colleagues, will plan their pathway into the unknown. Some researches will demand large groups of cooperating assistants, large units of expensive equipment, which will require a director who, in addition to his own scientific gifts, must needs have the power of appeal to younger colleagues and to supporting foundations or industries.

It is in the choice of a research director to take on the mantle of his predecessor in an organization that has already attained to eminence that the principal problem of research direction arises. To step into the vacant directorship is no light undertaking for any new incumbent, nor is his selection an easy responsibility for any governing board. The learned societies and the scientific academies must assume a large share in such responsibility. It is for them to realize that "the supply of competent candidates," as Dr. Buckley, of the Bell Telephone Laboratories, observes, "is lamentably low." He doubts "whether it could be successfully augmented by any systematic educational procedure. The problem is more to find than to develop those who have the necessary qualifications." Dr. Mees would apply the pragmatic test to those who are selected.

When an institute director is making a success and producing valuable work, his field of activity should be enlarged and the institute given increased scope. When he is doing only moderately well, it is probably unwise to expand his field even though he may blame insufficient support for his inability to produce results. Good men will produce results with a minimum of means, but, as soon as they do so, the further means should be supplied. Nor does he worry too much about the situation that may arise if the staff and even the director should be appointed for other reasons than their competence. "This difficulty will supply its own remedy. The institute will simply fail, and the advance of science, locally checked, will proceed elsewhere."

It seems reasonably certain that the selection of research directors and research professors will in the long run be most successful if the body responsible for selection consists primarily of scientific men. Breadth of interest within that body of scientists may help to promote wisdom of choice. The important chairs of science in Sweden are filled only after consultation with colleagues abroad. Within one American university at least, the nominations to a research professorship in any one science must be approved by the research committee representative of all the sciences there taught. It is also quite certain that largely non-scientific boards of control with power to formulate scientific programs for both war and peace and with power to prescribe personnel and facilities for those programs, as is true of certain proposals originating in this country from legislative sources, can not conceivably be productive of the scientific direction and potential that the country needs in either war or peace.

THE SUPPORT OF RESEARCH

In the field of industrial research there is no problem of support. Technological progress has revealed, in an ever-increasing measure, that research is the price of industrial development, that it can revolutionize the bases of industry, render obsolete the equipment and techniques of to-day in the new procedures of to-morrow. Facing a fight for survival by the competition which originates in the research laboratories, individual organizations and cooperating groups are deciding to insure their own financial stability and future by a large premium of research effort. There is abundant evidence that such insurance pays real dividends.

Although this is true of applied science, in basic science, from which all future applied science must inevitably stem, the financial problem of support is far from reassuring. Fundamental research is rarely directly or immediately profitable, nor can it readily be made self-supporting. Its principal assets are long-range in nature, whether from the body of workers which it produces or the new principles which it formulates from which applied science will ultimately derive the richest revenues. Faraday, formulating the principles of induction and the laws of electrolysis, is separated from the electrical age and the electrochemical industry by fifty years or more of technical incubation. Sabatier, in his humble laboratory in Toulouse, never shared in the wealth which the principles of catalysis that he laid down brought to a diversity of industries, in fat-hardening, synthetic alcohols and the petroleum industry. The discovery that the uranium atom undergoes fission processes induced by neutrons, while it makes the age of atomic energy attainable, will not secure the institutions in which such discoveries were made from future problems of support.

In large measure the support of fundamental scientific research has, in the past, been the proud privilege

of private philanthropy. Only in recent decades has any measure of support come from industry and government. This is especially true in the English-speaking world. In Germany, industry has been more closely knit to and has more handsomely supported, hitherto, the prosecution of basic science. In Soviet Russia, the great development of her modern science has been closely tied to the State, in agreement with the prevalent political ideology, both for direction and for support. What of the future?

For many reasons the outlook for support from private philanthropy is not inviting. The leveling influence of destructive warfare, the heavy taxation on incomes and inheritance which inevitably accompany such effort, all imply that institutions of fundamental research which have so richly drawn upon private fortunes in the past for their foundation and continuance face a leaner future so far as such sources of income are concerned. It will be necessary to take all measures possible to maintain such private donations in support of science at as high a level as can be achieved, since it is certain that support of such a nature is, of all support, the most desirable and the least hedged around with difficulties of administration. If the accumulations of wealth in the future, being less, imply a decrease in the size of individual fortunes and a consequent diminution in size of donations to research, ways must be found to increase the number of donations that can be secured. The broadening interest in the potentialities and effects of scientific research should result in a broadening of the bases from which private support might come. Research scientists and research directors incur in this respect a definite obligation to the areas in which their work is in progress. Civic and state contacts with successful research work should amplify civic and state support if for reasons of local pride alone. The obligations of research scientists do not end when they have achieved successfully the scientific objectives which they set themselves. That something has been lacking hitherto in scientist-donor contacts is evident from some observations of Dr. Buckley:

> It seems to me that those concerned with the support of fundamental research have not taken into adequate account the need for winning recognition and acclaim for the donor. Those who conduct researches and publish their results are commonly very much concerned with their own recognition and very desirous of public acclaim. They have been notably deficient in calling public attention to the source of funds with which the work was done. In this regard, it seems to me that not only has real injustice been done, but research workers have failed to win support which they might have won had this matter of recognition for the donor been given proper attention, particularly in the case of private donations. This is a problem not easily solved, and I think there is real need for development of a technique of recognition that treats the donor fairly and that does not result in the promotion of donations in ways which will be unfortunate.

The officers of the American Philosophical Society have frequently noted this type of blind spot in the recipient of research support. The disease should be cured if for no other reason than that fair and encouraging recognition of donors is productive of wider donor activity. Giving is contagious.

The support of fundamental research by industries is a problem of great complexity. It has been argued by some that boards of direction of industry have no right to utilize the stockholders' monies in support of scientific research, the bearing of which on the profit-making of the industry is at best arguable and at worst very remote. The legal aspects of such support have been debated on many occasions. The returns to an industrial donor are generally indirect and are normally of benefit to the donor industry and its competitors alike. Industries of great breadth of activity with highly developed industrial research organizations of their own can most easily accommodate themselves to these factors in industrial support of basic research, and seize swiftly for their own advantage the results that accrue from such support. Taking the long-range view and admitting that immediate profits from new discoveries are rare, we must concede that industry does receive benefit from fundamental research in at least two important directions. The supply of adequately trained research workers inevitably increases in centers of intense research activity. The new discovery is as luring as gold in the Yukon Territory. Further, the broadening of understanding that accompanies each new scientific discovery means for the industrial research laboratory a surer, swifter and more economical approach to its own objectives. The history of synthetic toluene is instructive in this regard. In both World Wars I and II the need for toluene far exceeded the peace-time production from coal-tar sources. As early as 1916, in World War I, the possibility of producing toluene from petroleum source materials was realized. But expenditures running into millions of dollars did not solve the industrial problem at that time. Two decades of research in the basic aspects and principles of catalysis were needed to indicate in what direction the program, which led to failure in 1914–1918, could surely and swiftly be brought to a simple technical solution. There are many examples which could be cited of the auto-accelerating effects of basic scientific discoveries on the objectives of industrial research. Large industries have already decided, and will in increasing measure in the future decide, to support fundamental research.

What of the decentralized industries that operate

in small, widely distributed units with only a relatively small number capable of maintaining research laboratories for their industrial problems? What measure of support for pure science can they supply? How can they meet the competition from without, to which large industrial research organizations by the breadth of their own research efforts subject the little industry? The answer would seem to lie in a cooperative effort shared in limited amount by each but, in aggregate, large and impressive. It would seem to lie in the development of the research institute, whose main objectives should be (1) the prosecution of fundamental studies in the general field of the pertinent subject, its physics, chemistry, biological and engineering aspects, (2) the dissemination of research information covering scientific and economic aspects of the field, and (3) the training in the methods of research of specially selected personnel at the graduate student level for future positions of responsibility within the industry. Coordinated with an existing educational foundation, such a research institute could produce mutual advantages for both. Each would enlarge its own research horizons, each could supplement the others' activities with personnel and facilities. The advent of the cooperative research institute in the educational centers of the land can be made of significant importance in the general problem of support for research.

State and Government support of fundamental research is at once the most obvious and at the same time the most hazardous of all the forms of support. By its nature it recognizes that the endowment of research is the concern of all citizens alike and all should share in its burdens and its benefits. Such support tends, at the same time, to enmesh the laboratory with the hurly-burly of competing ideologies or conflicting interests that hamper even the most liberal forms of government and, in the worst cases, tend to destroy that independence of scientific opinion, that autonomy of science, without which it can not fulfil its proper functions to society. We are too near to recent efforts to break the autonomy of scientific effort, to subordinate it to State ideologies and totalitarian control, to be unmindful of its real dangers. We must not forget that even democratic legislative bodies have attempted to define $\pi = 3$, in the supposed interests of their growing youth. Can we hope, in these democratic forms of government, for that larger measure of political wisdom that is prepared to surrender to competent scientific bodies, such as the National Academy of Sciences, the problem of disposition of community support to scientific sections of the universities and research foundations, freeing it thus from every vestige of political or ideological control? The history of the relations between the United States Government and the National Academy of Sciences in the past does not augur well for future improvement in this regard. May we not hope, however, that the lessons of these harsh years, in which scientifically trained university presidents, executive officers of scientific and research foundations, professors of science, have crowded the offices of government departments in striking contrast to the days of peace, may we not hope that those lessons will show that the peace can be lost, has in the past been lost, because of neglect or oversight of the major role that scientific discovery, no less than applied science, plays in those days of peace? May we not hope for the realization that, no less in peace than in war, local, state, national and international relations, social and political affairs, have become inseparable from the discoveries of the scientist in his laboratory and their manifold applications? And, realizing this, may we not hope for that measure of disinterested financial support which shall best promote that scientific harvest? To secure this with maximum efficiency and least impedance it seems necessary that the scientists shall be masters in their own households.

But, masters in their own households, there still lies upon them the paramount necessity of integrating their skills and their findings with the broad stream of life which flows outside the laboratories. To go forward to meet the years of difficulty ahead, we shall need the effort of all men of good will, among whom the scientist, by the nature of his calling, must certainly be numbered. The processes of mutual cooperation and assistance among the individual sciences must be multiplied. The isolation of one science from another must become progressively less and less, even though the degree of specialization within a science becomes perhaps greater and greater. This calls for an increasing breadth of culture and of education among the scientists, an increasing dedication by the noblest minds to the forward march of knowledge; but it calls also for a fuller appreciation of the social consequences of that knowledge, a franker recognition of the other factors contributory to true knowledge, to wisdom. "The modern world," says Maritain, "by which I mean that world which is coming to an end before our eyes, has not been a world of harmony between forms of wisdom, but one of conflict between wisdom and the sciences, and," he adds, "it has seen the victory of science over wisdom." Have not we scientists, so to speak, to surrender that victory? We shall not yield our energy, our courage, our diligence in search of truth. We shall but renounce the primacy to which a sick world has thrust us; and we shall gain by our renunciation. In the free world to which we

still dare to look forward, with the soldiers and statesmen, artists, humanists, philosophers and priests, we must integrate our scientific skills with the social and spiritual aspects of human life and nature. That goal attained, we shall not lack either direction or support for the physical sciences.

OBITUARY

EDWARD OSCAR ULRICH

EDWARD O. ULRICH was the last survivor of the five great invertebrate paleontologists who were the dominating figures in Paleozoic work in 1900. Charles E. Beecher died forty years ago. John M. Clarke, Charles D. Walcott and Charles Schuchert fortunately survived much longer, and, with Ulrich, were universally considered the leaders in the field so long as they lived. These four paired admirably: Walcott and Clarke, suave, diplomatic, executive; Ulrich and Schuchert, blunt, outspoken, indefatigable workers, zealous for detail. Each was a man of strong personality. They were at times great friends, at others great foes. But all of them were seeking scientific truths. The writer came to know all of them, and the thing which stands out best in his memory is that, however much we differed on scientific matters, we were always good friends.

Ulrich was a delightful personal companion, equally eager to argue or joke. But he was always good-natured. I never knew him to express anger, no matter what he might feel.

But this is neither a biography nor an appreciation. Since I heard of his death, I have been trying to appraise his position in the field of invertebrate paleontology. It seems to me that he was the greatest descriptive paleontologist that America has ever produced. He had a remarkable eye for form and a genius for detail. His memory was extraordinary. It is doubtful if he forgot the details of any species he ever studied. In contrast to much of the rather hasty work of some of his contemporaries, his descriptions have stood the test of time. His skill as an artist and lithographer was probably the basis of his success. After the publication of his work for the Illinois and Minnesota State Surveys he was accused of making far too many species, the innuendo being that he was paid for his labor at so much per new species. Later workers have shown that his species were good, and that he could have made many more if he had had access to more and better material. His work is the foundation for later studies on Paleozoic Bryozoa, Ostracoda and Conodonts, Ordovician Gastropoda and Pelecypoda. He also contributed much to knowledge of Cambrian and Ordovician trilobites and Mississippian pentremites.

During his long life, Ulrich probably saw more of the Paleozoic formations of the eastern half of the United States than any other man. His contributions to stratigraphy and correlation were voluminous, not only in what he himself published, but in the aid which he gave to other geologists during the many years of his association with the U. S. Geological Survey. Some one else will have to appraise this side of his work, for his ideas were so diametrically opposed to those of the present writer that he can offer no judgment. But he made a great contribution in this field, for he provoked—and I really mean provoked—many geologists to make much more careful studies than would otherwise have been done. His discussions furnished food for thought, and much good came of them.

Edward Oscar Ulrich was born in Cincinnati on February 1, 1857, and died in Washington on February 22, 1944. He was a member of many learned societies, and a great contributor to knowledge in his field. His was a useful life, well lived. If it had not been for him, we should have had no Schuchert in geology, and there are many others who owe their start to him.

PERCY E. RAYMOND

MUSEUM OF COMPARATIVE ZOOLOGY,
CAMBRIDGE, MASS.

DEATHS AND MEMORIALS

DR. HARRIS HANCOCK, who retired with the title emeritus in 1937 as professor of mathematics at the University of Cincinnati, died on March 19. He was seventy-seven years old.

DR. BENJAMIN MILLER, since 1907 head of the department of geology of Lehigh University, died on March 23. He was in his seventieth year.

DR. CARL KOLLER, consulting ophthalmic surgeon at the Mt. Sinai and Montefiore Hospitals, New York City, died on March 21 at the age of eighty-six years.

AT the graduating exercises of Lafayette College on March 26 a memorial address was made by Dr. B. W. Kunkel, professor of zoology, on "The Life of Dr. J. McKeen Cattell," who graduated from Lafayette College in 1880.

SCIENTIFIC EVENTS

THE FACULTY OF SCIENCE OF THE UNIVERSITY OF ANKARA

Nature gives an account of the opening, in the presence of President Inönü, on November 8, 1943, of a new Faculty of Science in the University of Ankara. The president, accompanied by the Prime Minister, Sükrü Saracoglu, was welcomed at the inauguration ceremony by the chairman of the National Assembly, B. B. Abdülhalik Renda. All the members of the Cabinet were present; R. F. Lucas, of the British Council, was also invited to attend the ceremony.

The Minister of Education, Hasan Ali Yücel, in his opening address, referred to Turkish progress during the twenty years since the establishment of the Republic. The consequent changes in the national outlook have developed a need for scientific and technical training which is now enhanced by the mechanization of armed forces in a world at war. Hitherto Turkish educational institutions have lacked equipment for practical training; but Turkey has now an established policy of education based on positive knowledge to reinforce the earlier practice of theoretical training only. The nation needs mechanical engineers, mining and civil engineers, and the great problem of Turkey to-day is to find the means for training students in large enough numbers to satisfy the national requirements without reducing the educational standard. The Government is keenly aware of these needs and has sanctioned the establishment of this faculty as a step to meet them. The assembly was later addressed by the rector of the faculty, by a student and by Professor Kerim Erin, of the Faculty of Science, University of Istanbul.

The new faculty is temporarily installed in the Gazi Teachers' Training Institute. The dean of the faculty, Bay Hayri Dener, is also professor of physics and a member of the Board of Education. The chair of chemistry and the presidency of the new Chemistry Institute of the faculty is held by Dr. Avni Refik Bekman. The Ministry of Education has invited the British Council to nominate British candidates for a professorship in each of the existing departments of chemistry, physics and mathematics. The establishment of this faculty thus implements the approval of the bill recently presented by the Turkish Cabinet to the Chamber of Deputies.

THE MAY CONVENTION OF THE SOCIETY OF AMERICAN BACTERIOLOGISTS

THE Society of American Bacteriologists will convene in New York City at the Hotel Pennsylvania on May 3, 4 and 5 for the first time since December, 1941. The 1942 convention, scheduled for Columbus, Ohio, was cancelled by the society at the request of the Office of Defense Transportation and no attempt was made to plan a meeting during 1943. The present officers of the society include: *President,* I. L. Baldwin, University of Wisconsin; *Past-president,* Rebecca C. Lancefield, Rockefeller Institute; *Vice-president,* Stuart Mudd, University of Pennsylvania; *Secretary-Treasurer,* W. C. Frazier, University of Wisconsin, and *Councilors-at-Large,* Martin Frobisher, Jr., the Johns Hopkins University; W. J. Nungester, the University of Michigan; N. Paul Hudson, the Ohio State University, and L. S. McClung, Indiana University.

The program will feature wartime topics and recent research in bacteriology and will include: "Recent Advances in Our Knowledge of the Physiology of Microorganisms," C. B. van Niel; "Electron Microscopy in the Field of Bacteriology," V. K. Zworykin, James Hillier and Perry C. Smith; "Antibiotic Activity as Viewed by a Mycologist," Charles Thom; "Mode of Action of Antibiotic Substances," Selman A. Waksman; "Standardization of Assay of Penicillin," Albert C. Hunter; and "An Analysis of the Therapeutic Action of Penicillin Based on the Clinical Response of Patients and Correlated Laboratory Findings," W. S. Tillett; a series of six papers in a general symposium on "Rickettsial Diseases"; a series of six papers prepared for the committee on teaching; round-table discussions on (a) "Taxonomy," A. P. Hitchens, convener; (b) "Atypical Pneumonia," Frank L. Horsfall, Jr., convener; (c) "Anaerobic Bacteria," Ivan C. Hall, convener; (d) "Airborne Infections," Alexander Hollaender, convener, and (e) "History of Bacteriology in New York City," Augustus B. Wadsworth, convener; showing of programs of films by the committee on visual instruction in microbiology, and an exhibit of a new console model of the electron microscope by the Radio Corporation of America.

In addition to the above, the program will include approximately 130 other papers on various topics as well as 25 or more exhibits by sustaining members, committees or members of the society. The Eli Lilly Award of $1,000 and a medallion will be presented to a young bacteriologist in recognition of outstanding research accomplishment. The name of the recipient will not be announced until the annual dinner. The program will open at 10:00 A.M. on May 3. All sessions will be held in the Hotel Pennsylvania. Consistent with wartime conditions, all entertainment features have been eliminated from the program except the president's reception and dinner.

Members of the society will receive copies of the program from the secretary-treasurer; others may obtain information concerning the program from the chairman of the program committee, Dr. L. S. McClung, Indiana University, Bloomington.

THE PENNSYLVANIA ACADEMY OF SCIENCE

THE twentieth annual meeting of the Pennsylvania Academy of Science will open at York on Friday

afternoon, April 7, at two o'clock, under the presidency of Dr. Clarence A. Horn, of Albright College.

At the afternoon session, the address of welcome will be given by Dr. Arthur W. Ferguson, superintendent of schools of York. A program of scientific papers will be presented by members.

On Saturday there will be a "Symposium on Burns." This is expected to attract many teachers, first aid and medical people, as well as other members of the general public.

On Friday evening, Dr. Edgar T. Wherry, professor of botany at the University of Pennsylvania, will speak on the wild flowers and ferns of the lower Susquehanna Valley, an area particularly rich in rare rock ferns. His address will be illustrated with colored slides.

With the awarding of the Academy Research Grant at the coming York meeting, $1,000 will have been provided by the American Association for the Advancement of Science to carry on scientific investigations in Pennsylvania. Since 1935, the association has made available to the academy annually a sum of fifty cents for each member who is enrolled in the association. This has averaged $100. A standing committee on grants passes on all applications and administers the fund.

All meetings will be held in the William Penn Senior High School. The public is invited to attend.

THE DRAFTING OF SCIENTIFIC WORKERS

DR. CHARLES L. PARSONS, secretary of the American Chemical Society, following a conference in Washington, called by the society, has made public a statement protesting against the indiscriminate drafting of chemists, chemical engineers and other technically trained professional workers between the ages of eighteen to twenty-six.

The chairman of the committee that prepared the statement, approved by the representatives of the eighty-two companies participating in the conference, was L. B. Morris, director of personnel contact relations, Radio Corporation of America, Victor Division. Other members were E. T. Asplundh, vice-president, Columbia Chemicals Division, Pittsburgh Plate Glass Company; M. T. Carpenter, associate director of research, Standard Oil Company of Indiana; J. N. Forker, vice-president, Koppers Company, and E. P. Wechesser, administrator of Selective Service, B. F. Goodrich Company. The statement reads in part:

> It is the duty of this conference to bring to the attention of the President of the United States, as Commander-in-Chief of the Armed Forces, and of his principal military and production advisers, the facts governing a situation which can only be regarded as critical and as a direct threat to the successful prosecution of the war.
>
> Both our enemies and our allies are deferring technically trained men, despite an unquestioned drain on their manpower. It is urgently recommended that action be taken immediately to assure the deferment of non-replaceable employees in critical occupations in essential industries, regardless of age or marital status.

It is further pointed out that

> There has never been a surplus of chemists and chemical engineers in the United States; the need for such technically trained men has always been greater than the supply; the unprecedented demand for industrial chemicals, synthetic rubber, aviation gasoline, foods and drugs, including penicillin, blood plasma, anti-malarials and the sulfanilamides, has thrust upon the chemical and allied industries a responsibility which can be met only if trained personnel is available to direct research and manufacturing operations.
>
> If scientifically trained men are drafted in large numbers, production will suffer because the efforts of thousands of workers in war plants will deteriorate owing to the lack of proper supervision.

Dr. Parsons addressed a letter to President Roosevelt on March 14 in which he said that at the meeting of a hundred and twenty-five members of the American Chemical Society on the previous day it was agreed that war production "faced disaster if chemists, chemical engineers, physicists and certain other scientists were estopped from using their specific training in this war."

Mr. Roosevelt replied as follows:

> I have your letter of March 14 on behalf of the American Chemical Society. As you know, there is great demand for men under twenty-six for combat duty overseas. In order to meet that demand it may be necessary to dip into the pool of man power now being used for war production, government and agriculture. In every case there will have to be a determination as to where each man can render the best service.
>
> I agree that where young men possess special skill, training and qualifications in chemistry, chemical engineering, physics or other scientific fields it would deter the conduct of the war to take them from their scientific work. This is particularly true of new scientific developments in which younger men have probably received better training than the older scientists.
>
> I thank you for writing, and desire to assure you that the special need for such men in scientific work in industry will be kept in mind as we proceed to draw more and more younger men into the armed services.

The National Roster of Scientific and Specialized Personnel, which lists for war purposes scientific and technical workers, has not immediately available a count of men under twenty-six years. Those of 29 years and under as of July 1, 1943, as reported by Science Service are as follows: Aeronautical engineering, total 5,348—2,732 or 50 per cent.; chemical engineering, 14,115—9,049 or 64 per cent.; radio engineering, 5,589—1,748 or 32 per cent.; physics, 10,004—3,464 or 35 per cent.; chemistry, 65,410—28,332 or 42 per cent.; mathematics, 7,967—1,977 or 25 per

cent.; mechanical engineering, 24,651—7,008 or 28 per cent.; electrical engineering, 20,818—4,595 or 22 per cent.

THE WORCESTER FOUNDATION FOR EXPERIMENTAL BIOLOGY

THE Worcester Foundation for Experimental Biology, at Clark University, has recently been incorporated. The purpose of this organization is "to carry on investigations in the biological sciences, including the medical sciences." Professor Harlow Shapley, director of the Harvard Astronomical Observatory, is the president of its board of eleven trustees. Others on the board are Dr. R. G. Hoskins, director of the Memorial Foundation for Neuroendocrine Research; Dr. W. J. Crozier, professor of general physiology at Harvard University, and Dr. William Malamud, clinical director of the Worcester State Hospital and professor of psychiatry at Tufts College. Professor Hudson Hoagland, on war leave from his work at Clark University, is executive director of the foundation, and Dr. Gregory Pincus, visiting professor at Clark University, is director of laboratories. Researches sponsored by the foundation are being carried out by some dozen investigators.

The foundation is primarily interested in the general physiology and biochemistry of the hormones and respiratory enzymes and their possible interrelations. It is also concerned with applications of such work to studies of psychomotor fatigue, particularly in industry, and to neuropsychiatric problems. Extensive clinical facilities for the latter work are available at the Worcester State Hospital, where the research staff, including members of the Memorial Foundation for Neuroendocrine Research, are cooperating closely with the work of the foundation.

THE NAPLES ZOOLOGICAL STATION

SOME time ago the National Research Council received information that the Naples Zoological Station was physically intact and its staff still on the ground, with Dr. G. Montalenti as acting director. The following additional information has now been received: The aquarium is now open to Allied officers and soldiers on the payment of an admission fee. The Military Services have assisted the aquarium in its publicity and the promotion of visits by groups of soldiers.

Certain funds have been made available to the aquarium to replace the former state and city subsidies.

The Royal Society of London also has made a grant of £1,000 to the station for its 1944 program of research.

The Army has been assured by the acting director that with the above-mentioned assistance the aquarium and zoological station can now carry on an active program of research in which certain professors of the University of Naples and their students are participating.

ROSS G. HARRISON

SCIENTIFIC NOTES AND NEWS

THE Eli Lilly and Company Prize of $1,000 for 1944 will be presented on April 5 at the one hundred and seventh meeting of the American Chemical Society at Cleveland to Dr. Joseph Stewart Fruton, of the Rockefeller Institute for Medical Research, New York, in recognition of his "fundamental studies on the isolation, purification, mode of action and specificity of proteolytic enzymes of both plant and animal origin. The use of synthetic peptides as a tool in studying the specificity of enzymes was developed to a high degree and has afforded a new insight into the role of enzymes in the hydrolysis and synthesis of proteins."

AT the same meeting the Borden Company Prize for 1944 of $1,000 for research in the chemistry of milk will be presented to Dr. William Mansfield Clark, DeLamar professor of physiological chemistry at the Johns Hopkins University and chairman of the Division of Chemistry and Chemical Technology of the National Research Council, for his contributions to the application of acid-base theory to laboratory and plant practice. "As a result of his work and writings," according to the citation, "the old haphazard and often irrational procedures in the dairy industry and other industries have been fruitfully transformed during the past years to precise scientific manipulations."

OFFICERS of the Ecological Society of America have been elected for 1944 as follows: *President,* Robert F. Griggs, National Research Council; *Vice-president,* Alfred C. Redfield, Oceanographic Institution, Woods Hole; *Treasurer,* H. J. Oosting, Duke University; *Executive Committee Member,* J. M. Aikman, Iowa State College; *Editorial Board Ecology*—for Botany, Paul B. Sears, Oberlin College, and Hardy L. Shirley, Allegheny Forest Experimental Station; for Zoology, P. L. Errington, the Iowa State College; and G. E. Hutchinson, Yale University; *Editorial Board Ecological Monographs*—for Botany, F. W. Albertson, Kansas State College; for Zoology, H. E. Ewing, National Museum and U. S. Department of Agriculture; *Representative, Union of American Biological Societies,* Robert E. Coker, University of North Carolina; *Representative, National Research Council,* H. A. Gleason, New York Botanical Garden; *Chairman,*

Committee on Preservation of Natural Conditions, Curtis L. Newcombe.

AT the forty-ninth meeting of the Michigan Academy of Science, Arts and Letters, held in Ann Arbor on March 17 and 18, the following officers were elected: *President,* Alfred L. Nelson, chairman of the department of mathematics, Wayne University; *Vice-president,* Harry D. Ruhl, head of the Game Division of the Michigan State Department of Conservation; *Secretary,* Frederick K. Sparrow, Jr., of the department of botany of the University of Michigan; *Treasurer,* Mischa Titiev, of the department of anthropology; *Librarian,* Warner G. Rice, director of the library, and *Editor,* Henry van der Schalie, of the University Museums.

DR. HENRY C. FIXOTT, of Portland, Ore., has been elected president of the American College of Dentists.

NEW appointments to the medical faculty of Columbia University include Dr. Edgar M. Medlar, director of the Hegeman Memorial Research Laboratory, New York, as associate professor of pathology, and Dr. Samuel Gelfan, director of research of the Van Patten Pharmaceutical Company, Chicago, as assistant professor of physiology.

DR. JOHN D. LYTTLE, of the department of pediatrics of the College of Physicians and Surgeons of Columbia University, has been appointed professor of pediatrics in the School of Medicine of the University of Southern California and director of pediatrics at the Los Angeles Children's Hospital.

DR. FRANK E. EGLER, of the department of physics of Syracuse University and the department of botany of the New York State College of Forestry, has been appointed associate professor of physics at Knox College. He will maintain his connection with the Chicle Development Company.

DR. THOMAS PARRAN, of New York, has been nominated by President Roosevelt to be Surgeon General of the U. S. Public Health Service for another term of four years.

AT a recent meeting of the Executive Committee of the Board of Directors of the Long Island Biological Association, Professor Harlow Shapley, director of the Harvard Observatory, was elected a member of the board. Dr. Berwind P. Kaufmann, of the Carnegie Institution, Cold Spring Harbor, New York, was elected assistant secretary of the association and will carry on the work of the office of secretary, left vacant by the death of Dr. Chas. B. Davenport, until this office is again filled.

AUSTIN F. HAWES, since 1921 forester of the State of Connecticut, retired on January 30. William C. Shepard has been the acting state forester during February and March. Dr. Raymond Kienholz, of the department of forestry of Connecticut College at New London, becomes state forester on April 1.

DR. JAMES A. CRABTREE, executive assistant to the Surgeon General of the U. S. Public Health Service, who since April 1, 1943, has served as chief medical officer of the Office of Foreign Relations Administration, has been appointed acting chief of the health division of the United Nations Relief and Rehabilitation Administration.

DR. DAVID SARNOFF, president of the Radio Corporation of America, has been called to active duty as a colonel in the Army Signal Corps. In his absence Major General James G. Harbord, U.S.A., retired, chairman of the board, will take over the active management of the company.

GRANTS-IN-AID for research for the year 1944-45 have been made by the American College of Dentists to Dr. B. Gottlieb, of the College of Dentistry of Baylor University, Dallas, $300 for a histological study of dental caries; to Wendell L. Wylie, of the Dental School of the University of California, $500 for a study of the dental conditions of monozygotic twins, and to Dr. H. R. Hunt and Dr. C. A. Hoppert, of Michigan State College, East Lansing, $500 for the continuation of a study of inheritance in rat caries.

AT the College of Medicine of Wayne University studies on protein metabolism will be carried out under the supervision of Dr. John W. Hirshfeld, assistant professor of surgery, and Dr. Arthur H. Smith, professor of physiological chemistry. The project will be financed through the Office of Scientific Research and Development. The department of physiological chemistry of the College of Medicine has received a grant of $900 from the Gerber Products Company to be used in the study of cereal-milk products.

THE report for 1943 of the Rockefeller Foundation states that Dr. Charles N. Leach, of the Far Eastern field staff of the International Health Division, and C. G. Copley, of the Manila office of the foundation, returned to America last December on the exchange ship *Gripsholm.* Both had been interned since the fall of Manila. At that time, the Japanese looted the office of the foundation and destroyed all records. In China, Dr. Henry S. Houghton, director of the Peiping Union Medical College, and Trevor Bowen, its comptroller, are still imprisoned, and hope for their early return seems slight. The buildings of the college have been taken over by the military and the greater part of their contents has been removed.

DR. BRUCE L. CLARK, associate professor of paleontology and curator of the Museum of Paleontology of the University of California at Berkeley, is leaving for Mexico to make a study of Tertiary fossils. He

has completed a monograph on the Eocene faunas of South America and hopes to obtain specimens that will enable him to establish more accurately the correlations between North and South America.

DR. ANDREW TOPPING, deputy medical officer of health of the London County Council, has been appointed chief medical officer to the United Nations Relief and Rehabilitation Administration.

IT is reported in *Nature* that the British Medical Research Council has established a unit for research in human nutrition as part of its staff organization, and that Dr. B. S. Platt has been appointed its director. Temporary accommodation has been provided at the National Hospital for Nervous Diseases, Queen Square, London. Some part of the investigations undertaken by the unit will be directed toward nutrition problems in the tropics. Among other things, Dr. Platt will continue the work, for which he joined the staff of the council in 1938, of coordinating a program of nutritional investigations in the Colonies by arrangement between the Colonial Office and the council.

PROFESSOR HENRY A. MATTILL, director of the department of biochemistry at the University of Iowa, gave the annual Day Lecture before the Chapter of Sigma Xi of the University of Rochester on February 22. His subject was "The Long and Short of Nutrition."

AT the request of the Coordinator of Inter-American Affairs, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Paraguay and Peru have sent sixteen representatives to the University of California at Berkeley for a special course to be given by the new School of Public Health. There will be two terms of sixteen weeks covering problems of nutrition and personal hygiene; sanitary bacteriology and environmental sanitation; general education and sociology; public health administration, and health education. The teaching staff will include members of the School of Education and of the department of home economics and social welfare; the School of Medicine at San Francisco; and representatives of the U. S. Public Health Service, the Children's Bureau of the Department of Labor and the State Department of Public Health.

AN appropriation amounting to $135,732 for grants-in-aid for research has been made to the University of Wisconsin by the Alumni Research Foundation.

THE Medical Branch at Galveston of the University of Texas has received grants of $2,400 each for the support of fellowships in pharmacology from Frederick Stearns and Company of Detroit and from the Bilhuber-Knoll Company of Orange, N. J.

IT is stated in *The Museum News* that Eagle's Nest, the home of the late William K. Vanderbilt, Jr., at Huntington, Long Island, is to become a public museum and park. The will, filed in January, provides that the Vanderbilt Marine Museum, which was built on the grounds by Commodore Vanderbilt in 1922, the mansion with certain furnishings and the land shall become public property upon the death of Mrs. Vanderbilt or after she may cease to occupy the home. Administration will be by three trustees who are to offer the property first to New York State or then to the county or finally to the town of Huntington. If the gift is not accepted, the trustees after two years are to create an organization to control the museum and park. The will provides for a trust fund of $2,000,000 of which the income will be for operation and maintenance. Eventually this fund will be substantially increased from the residuary estate, the value of which has not yet been determined.

APPLICATION has been filed with the Federal Communications Commission for a unique type of FM broadcasting station for the Washington, D. C., area. The applications was filed in the name of the FM Development Foundation, organized by Professor Edwin H. Armstrong, of Columbia University, inventor of the FM system, and by C. M. Jansky, Jr., and Stuart L. Bailey, members of the Washington consulting engineering firm of Jansky & Bailey, who constructed the first FM station there. The proposed site of the station is at Olney, Md., and the transmitting equipment will be substantially a duplicate of Professor Armstrong's station at Alpine, N. J. The foundation is organized to carry on research to foster the development of the FM broadcasting art.

DISCUSSION

INSTIGATOR OF THE WEATHER BUREAU

THE issue of SCIENCE for December 24, 1943, in the biographical sketches contributed by Everett I. Yowell errs in crediting Cleveland Abbe with initiating "a system of daily weather reports and storm predictions which led to the establishment of the United States Weather Bureau" (page 553), and the tablet at the Abbe Meteorological Observatory in Cincinnati is wrong in calling him the "First official United States Weather Forecaster" (page 555). Instead, the credit for these achievements should go to Increase A. Lapham (1811–75) of Wisconsin.

On December 8, 1869, Lapham petitioned Congress to inaugurate a system of forecasts, reciting the losses of men and ships in storms on the Great Lakes and the success of the French weather service which organized a telegraphic weather service with maps in 1855 (Cong. Doc. Ser. No. 1431, Doc. 10). The bill requested by Lapham was introduced by Congressman H. E. Paine of the First Wisconsin (Milwaukee) District on December 14, 1869, and became law on February 9, 1870 (16 Stat. 369).

The Wisconsin Historical Society possesses a holographic letter from Abbe to Lapham dated January 7, 1870, acknowledging Lapham's authorship of the legislation in the words, "I must express the pleasure experienced in realizing the energy with which you are pushing the matter of a telegraphic meteorological system of storm warnings."

The society also has the holographic commission appointing Lapham assistant to the chief signal officer of the United States on November 8, 1870, signed by the chief signal officer, Albert J. Myer. According to the Annual Report of the Chief Signal Officer for 1871, Lapham had "supervision of the signal service on the lakes" (page 7), and Lapham's report in the same volume (page 167) shows that he issued a storm warning on the day of his appointment and continued making weather maps for forecasts until the end of the season of navigation.

The appointment of Abbe to a similar position at Washington took place on January 3, 1871 (*ibid.*, page 8) and he began forecasting on February 19, 1871, 103 days after Lapham.

It is also interesting to note that this society has two weather maps issued by Abbe for the Cincinnati Board of Trade and similar to those issued by the Western Union Telegraph Company at Cincinnati in continuation of Abbe's maps (see W. H. Alexander, "A Climatological History of Ohio," Columbus, 1923, pages 24–25). None of these maps contains isobars, forecasts or other "analysis." Only data of temperature and wind direction are given.

For a fuller account of Lapham and his contributions, reference is made to Eric R. Miller, "New Light on the Beginnings of the Weather Bureau from the Papers of Increase A. Lapham," *Monthly Weather Review*, February, 1931.

EDWARD P. ALEXANDER,
Director

STATE HISTORICAL SOCIETY,
MADISON, WIS.

A RELATIONSHIP BETWEEN DENTAL CARIES AND SALIVA

A CLEAR relationship has been discovered between the rate of starch hydrolysis by saliva and the incidence of caries in the individual. Without exception among those studied, individuals with extensive caries (twenty or more cavities) produce saliva which hydrolyzes starch under standard test conditions with extreme rapidity. Individuals without caries produce saliva which hydrolyzes starch very slowly.

In 51 careful case studies at the Forsyth Dental Infirmary and at Radcliffe College no one has been found whose salivary reaction is out of line. Table 1 reflects the data accumulated to date:

TABLE 1

Number of individuals	Number of cavities	Average time
4	0	44.5 min.
6	1 to 3	36.5 "
8	4 to 6	18.5 "
14	7 to 9	8.7 "
13	10 to 12	6.8 "
2	13 or 14	4.0 "
2	20 or 21	1.8 "
2	32 or 33	1.0 "

A more detailed report upon this investigation is in preparation and will appear later with speculations on fluoride and amino acid in relation to the caries problem.

NAOMI C. TURNER
EDWARD M. CRANE

CHEMICAL LABORATORY,
RADCLIFFE COLLEGE

THE USE OF RHODIUM IN BLOOD CHEMISTRY

A YEAR ago I noticed the symbol "Rh" used in a biochemical abstract. Working on the "Bibliography of the Metals of the Platinum Group," I wondered about the use of rhodium in blood chemistry, and following it up I received the following from Dr. Levine: "Although I agree with you in general, it is nevertheless difficult to assign names to substances of biological activity which are not duplicated in another branch. There are a number of agglutinable factors identified by the letters A, B, O, M, N and P. We couldn't use the letter R because this was previously used instead of O. The letters Rh seemed indicated, since it followed the alphabetical arrangement of other blood factors and at the same time shows its relationship to a blood factor in macacus rhesus."

As it seemed probable that this symbol would be used only in biochemical publications, there would be little probability of any confusion, but *Science News Letter* for November 27 has a half page article on a "New Blood Test," in which "Rh" occurs more than a dozen times, in such expressions as "Rh factor," "Rh blood" and even "Rh husbands." As "Rh" has been used as the symbol for the metal rhodium for more than a century, and has at least been seen by every

student of chemistry, it would seem better to give the Rhesus monkey's blood factor some other symbol. After reading the article in question some sufferers from "conjugal childlessness," with knowledge of chemistry but not biochemistry, might hope to effect a cure by injections of colloidal rhodium.

JAS. LEWIS HOWE
WASHINGTON AND LEE UNIVERSITY

AN INTERESTING REFERENCE TO LENGTH OF DAY AS AFFECTING PLANTS

DR. S. F. BLAKE, of the U. S. Department of Agriculture, has called my attention to an interesting reference in which length of day is considered a factor affecting the distribution of plants.

Arthur Henfrey, in his book "The Vegetation of Europe," published in 1852, discusses the flora of the British Islands in relation to the flora of Continental Europe. On page 169, he discusses the ranges of different groups as affected by various factors of climate, including maritime and continental influences.

It is interesting that he recognizes one portion of British plant life as apparently dependent upon length of day or the amount of direct sunlight, rather than upon mean temperature or other conditions of the climatic complex. Such plants, he theorizes, are circumscribed by lines which coincide with the parallels of latitude.

It is apparent in this theorem, which he had amplified no farther by discussion or experimental data, that Henfrey plainly saw the implications of length of day in the natural distribution of plants. His ideas, however, appear to have gotten no farther than the stage of philosophical statement. It was not until 1920, about sixty-eight years later, that our present experimental knowledge of length of day began.

H. A. ALLARD
U. S. DEPARTMENT OF AGRICULTURE

SCIENTIFIC BOOKS

BELOVED SCIENTIST: ELIHU THOMSON

Beloved Scientist: Elihu Thomson, a Guiding Spirit of the Electrical Age. By DAVID O. WOODBURY. With a foreword by OWEN D. YOUNG. xiii + 358 pp. 16 plates. Whittlesey House, McGraw-Hill Book Co., 1944. $3.50.

A REALLY good and lovely biography is a much rarer thing than a good and lovely life, so much richer is nature than man's art. Here is an extraordinarily good biography of one of the less widely popularized, but very potent figures in that generation of adventurers, discoverers and inventors who brought on what we call "the electrical age."

The subject of this book has all the marks of a Horatio Alger hero, but with the additional realism of association with many other such heroes who were his predecessors or competitors in the electrical age. By what amounts almost to a stroke of genius this biography is entitled "Beloved Scientist," for it characterizes so perfectly the amiable personal qualities which distinguished Elihu Thomson from many other inventors of his period and which greatly endeared him to all who knew him.

This book contains a most interesting account of the principal inventors of the "Electrical Age." It is much more than a biography of one person, for it is really a history of the electrical industry and its founders. Here one finds intimate and yet full-length word portraits of Edison, Brush, Westinghouse, Steinmetz, Pupin, Lempe, Van Depole, Maxwell, Kelvin, Tyndall, Gramme, Helmholtz, Crooks, Hertz, Roentgen, Silvanus Thompson and Marconi. The book is full of sketches of significant and yet little known events in the lives and labors of many of these men.

So far as Elihu Thomson is concerned he fits into this assemblage as one of the most interesting and inspiring of them all. His youthful precocity, his years of laboratory experiments in his own home, his high-school career as student and later as teacher and professor and finally his great career as inventor are described in a most interesting manner. His interest is shown not merely in electricity but in almost everything that he observed in nature or art. His curiosity regarding the causes of things was universal; for example, he made experiments to find out how laughing gas produces anesthesia and concluded that it was due to the absence of oxygen necessary for cerebral activity. He had little faith in the ordinary practitioner of medicine and always insisted on knowing why certain prescriptions were given—usually without getting a satisfactory answer, which then stirred him up to make experiments of his own.

While he was still in the Central High School of Philadelphia he was greatly interested in photography and in making lenses for microscopes and telescopes. He also began experiments on what we would now call a telephone. After he had joined the teaching staff at the high school his experiments extended to everything in connection with electric energy and its utilization. One extraordinary experiment of his has been commemorated at the Benjamin Franklin High School by a tablet which states, "This is the birthplace of wireless, 1875"; for there he found that electric waves were transmitted through the air and through

brick walls to a distance of about 100 feet. In 1875 a fundamental invention of his was the three-coil dynamo; another was the electrical magnetic regulator. The Centennial Exposition of 1876 gave him such a stimulus with respect to electric lighting that it led to a large number of his inventions in that field.

Thomson's discoveries and inventions during his high-school career were made in conjunction with Professor Edwin J. Houston, who generally claimed the major credit for his minor part of the work. In 1880 Thomson decided to leave the profession of teaching and to devote himself to a career as inventor. He accepted a call to organize the American Electrical Company at New Britain, Conn., and accompanied by one of his high-school seniors, E. W. Rice, he removed to that place. Amidst great difficulties there he carried out a series of remarkable experiments leading to several important inventions, among them the lightning arrestor and electrical welding. This was a period of breathless haste in patenting inventions. Among the leaders in this race were Edison, Thomson, Brush and Westinghouse. In the rough-and-tumble battle of the patents Thomson proved to be a shrewd business man as well as a great inventor, and when the New Britain Company tried to sell out surreptitiously to a competitor, it was found that Thomson controlled all his patents.

The Thomson-Houston Company was then removed to Lynn, Mass., where under wise business management it grew and expanded into one of the great electrical companies of that period. Many other inventors were added to the staff, many great inventions were patented. The "battle of the currents" was waged between Edison, who stood for direct current, and Thomson, who favored alternating current. Similarly, a battle was fought between Edison's incandescent light and the arc light of Brush and Thomson. In the end the alternating current, with Thomson's protective grounding, and the incandescent light won the larger support.

A partial list of his nearly 700 patents includes the lightning arrestor, electric welding, three-coil dynamo, cream separator, repulsion motor, magnetic blow-out, improved transformers, distributors, trolley-car and train control, improved x-ray tubes, high frequency radio apparatus, etc.

Infringement suits between the Edison General Electric Company and the Thomson-Houston Company led in 1892 to the consolidation of the two in the General Electric Company with one principal branch at Schenectady, N. Y., and the other at Lynn, Mass. Thomson and his associates then turned to the application of his "repulsion motor" to the fruitful field of electric traction; he devised the leading type of electric meter, he experimented with x-rays and wireless.

After 1900 Thomson retired from the race of invention and devoted much attention to consultation and cooperation in many scientific and educational lines. For 37 years and until near his death at the age of 83, he continued to take an active part in the general advancement of science. He had from his earliest youth been greatly interested in astronomy, and in these later years of leisure he cooperated with Percival Lowell and W. H. Pickering and especially with George Hale. He undertook to make of fused quartz the 200-inch mirror for the Mt. Palomar telescope, but after long and costly experiments found that it was impracticable. He served for a time as acting president of the Massachusetts Institute of Technology and for many years on its board of trustees. On March 13, 1937, he died at his home in Swampscott, full of years and honors.

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SPECIAL ARTICLES

RELATION OF DUAL PHENOMENON IN PENICILLIUM NOTATUM TO PENICILLIN PRODUCTION

DIFFICULTIES in penicillin production have been reported recently by a number of those engaged in this work. Foster, Woodruff and MacDaniel[1] state that cultures of *Penicillium notatum* Westling "tend to lose spontaneously their ability to form penicillin either entirely or partially," and that "frequently degenerated cultures show a marked reduction in the tendency to sporulate abundantly." An additional complaint concerns the increase in yellow pigment which accompanies this degeneration.

In view of the nature of the difficulty we have made a single spore analysis of a stock culture of the fungus according to the method of Hansen and Smith.[2] The results have shown that *P. notatum* is a dual fungus, composed of two distinct constituents associated together in culture. This is the dual phenomenon discovered by Hansen[3] in 1938 and which has been found to be characteristic of most if not of all fungi.

The two components of *P. notatum* are a normal conidial or *C* type and an abnormal mycelial or *M* type. The *M* type arises repeatedly as a mutation in physiologically aging colonies of the *C* type, even though the culture be started from a single conidium.

[1] J. W. Foster, H. B. Woodruff and L. E. MacDaniel, *Jour. Bact.*, 46: 421, 1943.

[2] H. N. Hansen and R. E. Smith, *Phytopath.*, 22: 953, 1932.

[3] H. N. Hansen, *Mycologia*, 30: 442, 1938.

This mutation is probably of a genetic nature, and may be associated with sex, as has been shown by the writers[4,5] in another fungus. The *M* type is physiologically as well as morphologically distinct from the *C* type, and where mass transfers of inoculum are employed the *M* type is apt to become predominant. The appearance of the *M* type *de novo* in a *C* type culture is a function of physiological age. Pure cultures of the *C* type which are maintained in a state of youth by frequent transfer (always made by means of conidia) tend to remain free of the *M* type.

Presence of the *M* type in what appears to be a normal culture often remains undetected unless the culture be frequently analyzed by the single spore technique,[2] when some of the single spores will be found to produce the normal sporulating *C* type and others to produce the non-sporulating *M* type with which is associated an increased production of yellow pigment. This *M* type (non-sporulating and pigment-producing) is presumably the form which various workers have reported as being a poor producer of penicillin. The presence of the *M* type in cultures used for inoculum would be expected therefore to result in decreased penicillin production.

If our interpretation is correct, it would appear that the highest yield of penicillin probably could be obtained by frequently making single spore cultures of the fungus and choosing the most productive of these for large-scale operations, whether these be slight variations within the *C* type or even in the *M* type.

If it is desired merely to return the present stock culture to its highest sporulating condition it is suggested that a procedure somewhat as follows be adopted. Gently flush conidia from the agar slant stock culture with sterile water. Flood the surface of an agar medium in a plate or flask with this conidial suspension; pour off the excess suspension and incubate the inoculated medium in diffuse light. Harvest the new crop of conidia soon after they are formed, again using the flushing method to avoid carrying over mycelial fragments into the suspension. This spore suspension from this fresh culture should be pure for the *C* type. Cultures must never be scraped to obtain inoculum if the *M* type is to be avoided.

M types rarely mutate. If an *M* type is found which produces a satisfactory yield of penicillin it probably may be propagated by mass transfer without recourse to the above methods. If it is desired to distribute this inoculum through a liquid to serve in place of a spore suspension the mycelial colony may be cut up by means of a Waring blender.[6]

It should be clear that to maintain penicillin production at maximum levels the highest yielding clone of *P. notatum* should be used and that this clone be kept monotypically pure and free from recurring mutants. It should be evident also that where biological assay of penicillin is practiced, the assay organism too must be perpetuated in a monotypically pure state. Only when this is done is it possible to effectively standardize the processes of penicillin production and assay.

[4] H. N. Hansen and W. C. Snyder, *Phytopath.*, 30: 787, 1940.

[5] *Idem*, *Amer. Jour. Bot.*, 30: 419, 1943.

[6] C. F. Andrus, *Phytopath.*, 31: 566, 1941.

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AN ANTIBIOTIC SUBSTANCE FROM SPECIES OF GYMNOASCUS AND PENICILLIUM

THE antibiotic substances from three different fungi, namely, *Aspergillus clavatus, Penicillium patulum* and *Penicillium claviforme,* and variously called clavacin, claviformin and patulin have proved to be identical.[1] Raistrick *et al.*[1] have elucidated the chemistry as anhydro-3-hydroxymethylene-tetrahydro-γ-pyrone-2-carboxylic acid (patulin). This substance has now been isolated from two more mold species. The first was an undefined species of *Gymnoascus,* labelled 5070.1, and kindly furnished by Dr. Thom. The second was *Penicillium* sp. freshly isolated from soil in the course of a survey. Cultivated for 7 to 10 days on Czapek-Dox medium containing 3 per cent. corn steep liquor, the *Gymnoascus* filtrate inhibited *Escherichia coli* at 1/100 and *Staphylococcus aureus* at 1/50. The active agent was adsorbed on 1 per cent. norite, eluted with acetone, and the eluate concentrated *in vacuo* to a thin syrup. After standing overnight in a refrigerator, crystals appeared. They were separated by filtration and recrystallized twice from hot 50 per cent. ethanol. The white crystals melted at 109°. A mixed melting point with crystalline clavacin (m. 109.5°), from *Aspergillus clavatus* kindly supplied by Dr. Waksman, showed no depression. The substance analyzed as follows: C, 54.72; H, 3.98 (theoretical: C, 54.53; H, 3.93); molecular weight (cryoscopic in ethylene dibromide), 195. $C_7H_6O_4$ requires 154. The 2,4-dinitrophenylhydrazone derivative began to darken at 190° and did so progressively up to 250° C. without melting. The

[1] I. R. Hooper, H. W. Anderson, P. Skell and H. E. Carter, SCIENCE, 99: 16, 1944; S. A. Waksman, E. S. Horning and E. L. Spencer, SCIENCE, 96: 202–3, 1942; H. Raistrick, J. H. Birkinshaw, S. E. Micheal and A. Bracken, *Lancet,* 245: 625–34, 1943; B. P. Weisner, *Nature,* 149: 356–7, 1942; F. Bergel, A. L. Morrison, A. R. Moss, R. Klein, J. Rinderknecht and J. L. Ward, *Nature,* 152: 750, 1943; E. Chain, H. W. Florey, M. A. Jennings and D. Callow, *Brit. Jour. Exptl. Path.*, 23: 202–5, 1942.

acetyl derivative melted at 116° (Raistrick *et al.* give 116–118°; Hooper *et al.*, 116–117°). The substance is neutral, is rapidly destroyed by alkali and decolorizes permanganate. These properties correspond with published data on patulin and clavacin, and this substance is, therefore, identical with the other two.

The pure material is quite toxic for mice. L.D. 100 = 12.5 mg per 20 g mouse. It failed to protect mice against lethal *Salmonella schotmulleri* infections in the highest doses tolerated.

A crystalline substance isolated as above with slight modifications from culture filtrates of *Penicillium* sp. also proved to be identical with clavacin. The substance melted at 109.5° and showed no depression mixed with authentic clavacin. It analyzed as follows: C, 54.92; H, 4.04. Other properties coincide with those of clavacin.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

INOCULATION OF MEDIA FOR MOLD CULTURE

IN the cultivation of molds in large flasks or bottles it is sometimes difficult to obtain a uniform degree of inoculation and to produce an even growth over the entire surface of the medium. A technique used successfully in this laboratory with several species of Penicillium employs a suspension of spores in a medium containing gum tragacanth in which a small amount of lanolin has been emulsified. The particles of lanolin apparently assist in buoying the spores to the surface of the culture medium and holding them there until germinated.

A homogenous emulsion is prepared by warming and stirring 2.5 g gum tragacanth and 0.5 g lanolin in 100 ml of water. Thirty grams of the mixture is placed in a 125 ml Erlenmeyer flask, together with five 12–15 mm glass marbles, the flask is plugged with cotton and sterilized. The flask is then rotated or shaken to emulsify the lanolin while being cooled to 30° C or below. Flasks of gum-lanolin mixture prepared in this way may be stored in the refrigerator indefinitely. To use this gum-lanolin mixture to prepare a spore suspension, the contents of one flask, including the marbles, are poured onto a spore culture grown on agar in a 250 ml flask. The flask is now shaken gently for several minutes with a circular motion in a horizontal plane to cause the marbles to roll over the spore-bearing suface. The spore suspension is further diluted for use by adding 25 ml of sterile water. The resulting suspension measures 45–50 ml and in the case of *Penicillium notatum* suffices to inoculate 15 or more 3-liter Fernbach flasks, the area of the medium in each being about 270 square centimeters. The inoculated flasks are thoroughly agitated by shaking just before incubation and are then allowed to remain undisturbed. This method is readily adapted to a sixfold increase in scale by growing the sporulation culture in a 3-liter Fernbach flask and modifying the rest of the procedure accordingly. For each Fernbach flask use 180 g of tragacanth-lanolin emulsion, increase the number of marbles to about a dozen and finally dilute with 150 ml of sterile water.

Methyl cellulose in place of gum tragacanth was not satisfactory because it did not properly emulsify the lanolin. Cetyl alcohol in place of lanolin or an eightfold increase in the amount of lanolin inhibited mold growth. If the medium being inoculated contains much suspended matter which settles out, the inoculation is less satisfactory. Presumably the material settling to the bottom counteracts the buoyant effect of the lanolin particles. This difficulty is corrected by filtration of the medium. The incorporation of a wetting agent, such as 0.1 per cent. Ivory soap or 0.4 per cent. Aerosol A.Y. in the gum-lanolin emulsion facilitated the loosening of spores from the mycelium but inhibited spore germination and mold growth.

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BOOKS RECEIVED

ABRAMSON, DAVID I. *Vascular Responses in the Extremities of Man in Health and Disease.* Illustrated. Pp. x + 412. University of Chicago Press. $5.00.

DREHER, EMIL. *The Chemistry of Synthetic Substances.* Illustrated. Pp. 103. Philosophical Library. $3.00.

HEUSER, EMIL. *The Chemistry of Cellulose.* Illustrated. Pp. v + 660. John Wiley and Sons. $7.50.

HOAGLAND, D. R. *Lectures on the Inorganic Nutrition of Plants.* Illustrated. Pp. 226. Chronica Botanica. $4.00.

LANGEWIESCHE, WOLFGANG. *Stick and Rudder. An Explanation of the Art of Flying.* Illustrated. Pp. vi + 389. Whittlesey House. $3.75.

OBERLING, CHARLES. *The Riddle of Cancer.* Translated by WILLIAM H. WOGLOM. Pp. vii + 196. Yale University Press. $3.00.

United States Department of the Interior. Fish and Wildlife Service. *Studies on the Pacific Pilchard or Sardine (Sardinops Caerulea).* Special Scientific Report Numbers 19 to 24.